Biographical Portrait

WALLACE L. FONS

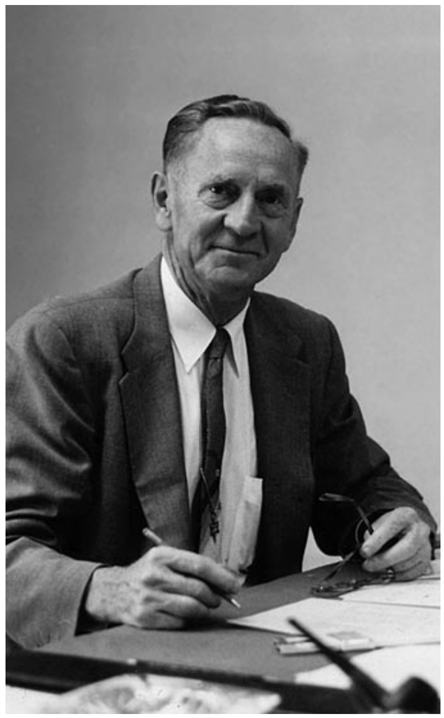
FIRE RESEARCH PIONEER

by David R. Weise and Ted R. Fons

During his 30-year career with the U.S. Forest Service, Wally Fons laid the foundation for much of the understanding we have today of forest fire's many properties by applying his mechanical engineering background. He left a legacy of research that formed the basis for the fire behavior and danger systems still used in the United States. In addition to fire behavior topics, he applied his engineering skills to many other forestry-related issues.

Wallace Leo Fons was born November 23, 1899, in Ashland, Wisconsin, to Leon and Rose Fons. He started working for Standard Oil Company in Patterson, California, as a pumping plant operator in August 1918. After spending half a year at University High School in Oakland, he entered the University of California in May 1925 and completed a B.S. in mechanical engineering in 1930. He continued to work for Standard Oil as an engineer until 1931, when he was laid off during the Great Depression and returned to his alma mater to pursue a master's degree in mechanical engineering. From 1931 to 1933 he worked as a laboratory assistant to L. M. K. Boelter (for whom the Schmidt-Boelter heat flux sensor is named) in a photometric lab and studied the relationship between headlamp construction and automobile road performance. In December 1933 he was hired by the Division of Fire Research at the California Forest Experiment Station (now the Pacific Southwest Research Station) of the U.S. Forest Service, the agency he worked for until his death in 1963.

In Fons's initial assignments, he assisted in studies looking at the effects of solar illumination of smoke plume detection by a human observer and designed methods to store rainwater in catchments for fire suppression. Another fire research pioneer, George Byram was performing related research on visibility and smoke plume detection at the Appalachian Forest Experiment Station in Asheville, North Carolina. Fons also began to assist in forest fire behavior studies and was part of the research team that conducted experiments in ponderosa pine (*Pinus ponderosa*) surface fuels, measuring the rate of perimeter growth as a function of various environmental factors. This work, similar to the field-based approaches taken in Canada and Australia in the early days of fire research, established some of the basic understanding of fire spread in uniform, dead fuels and would later influence the development of the Rothermel fire spread equation.


COURTESY OF TED FONS

Wallace L. Fons at his desk at the Southern Forest Fire Laboratory, Macon, Georgia.

The California fire research group, whose other members were John R. Curry, Charles C. Buck, and H. D. Bruce, produced an analysis of fire behavior research needs. In charge of research on forest fuels and wind measurement, Fons helped map active fires and measure weather and fuel moisture on the Shasta National Forest to develop information for firefighters.[1] He also assisted Curry in perhaps the first experiments in the United States designed to investigate the effects of wind and fuel moisture on fire growth in uniform fuel beds of ponderosa pine needles.[2]

Fons returned to his studies in mechanical engineering in 1938 and earned his master's degree in 1940. His thesis research produced the first physically based fire spread model in the Western Hemisphere, if not the world.[3] During this time, Fons used a variety of state-of-the-art anemometers to measure low-velocity winds, improving understanding of wind flow beneath, within, and above a forest canopy. His work identified the similarities and differences in wind flow in forests, shrubs, and grasslands.

The California fire research group identified more than 70 problems related to fire suppression in California that required further research.[4] As Fons and others sought to conduct controlled studies of fire behavior in which various factors were held constant to isolate effects, the need for specialized equipment became evident. Fons used his mechanical engineering background to build the first wind tunnel used to study wind effects on fire spread.[5] The wind tunnel was used outdoors first on the Shasta Experimental Forest, in northern California, and then was moved to the San Dimas Experimental Forest in the San Gabriel Mountains of southern California. It was the only wind tunnel used to study wind effects on fire until the Southern

Forest Fire Laboratory in Macon, Georgia, was built in 1958.

Other fundamental work conducted by Fons and his colleagues from 1936 to 1950 examined how the physical and chemical properties of fuels affected ignition and the rate of combustion. He studied the effectiveness of "wet" water for fire suppression and found that its use could lengthen the time when fuels would not easily ignite, thus giving a fire manager more time to suppress a fire. Buck, Fons, and Clive Countryman developed equations to predict postfire erosion on southern California's four national forests, areas well known for their frequent catastrophic fires followed by mudslides.[6] This seminal work is still used today.

With the close of World War II and the advent of the nuclear age, Fons and other Forest Service scientists became involved in a series of classified studies. Several of these were concerned with the blast effects from nuclear weapons and the potential impacts on forests, including ignition of forest fires. Some 22 reports were produced from this work between 1950 and 1960; many are now declassified and available through the Defense Technical Information Center (www.dtic.mil). The studies initially were overseen by Professor R. Keith Arnold at the University of California, with Fons serving as the Forest Service's project leader.

One series of studies examined the fundamental thermal properties of various forest fuels. These studies produced information on thermal conductivity, specific heat, absorptivity, and other properties of many common fuels found in the United States—information that is still relevant today.[7] Another series of studies focused on the blow-down of trees and involved tests and measurements to determine the ability of a tree trunk to bend, the composition and distribution of biomass in tree crowns, and air flow through a forest canopy.[8] A video of the blast effects on the artificial ponderosa pine forest constructed in Nevada is available on the Internet (http://bit.ly/1wvzGP6).

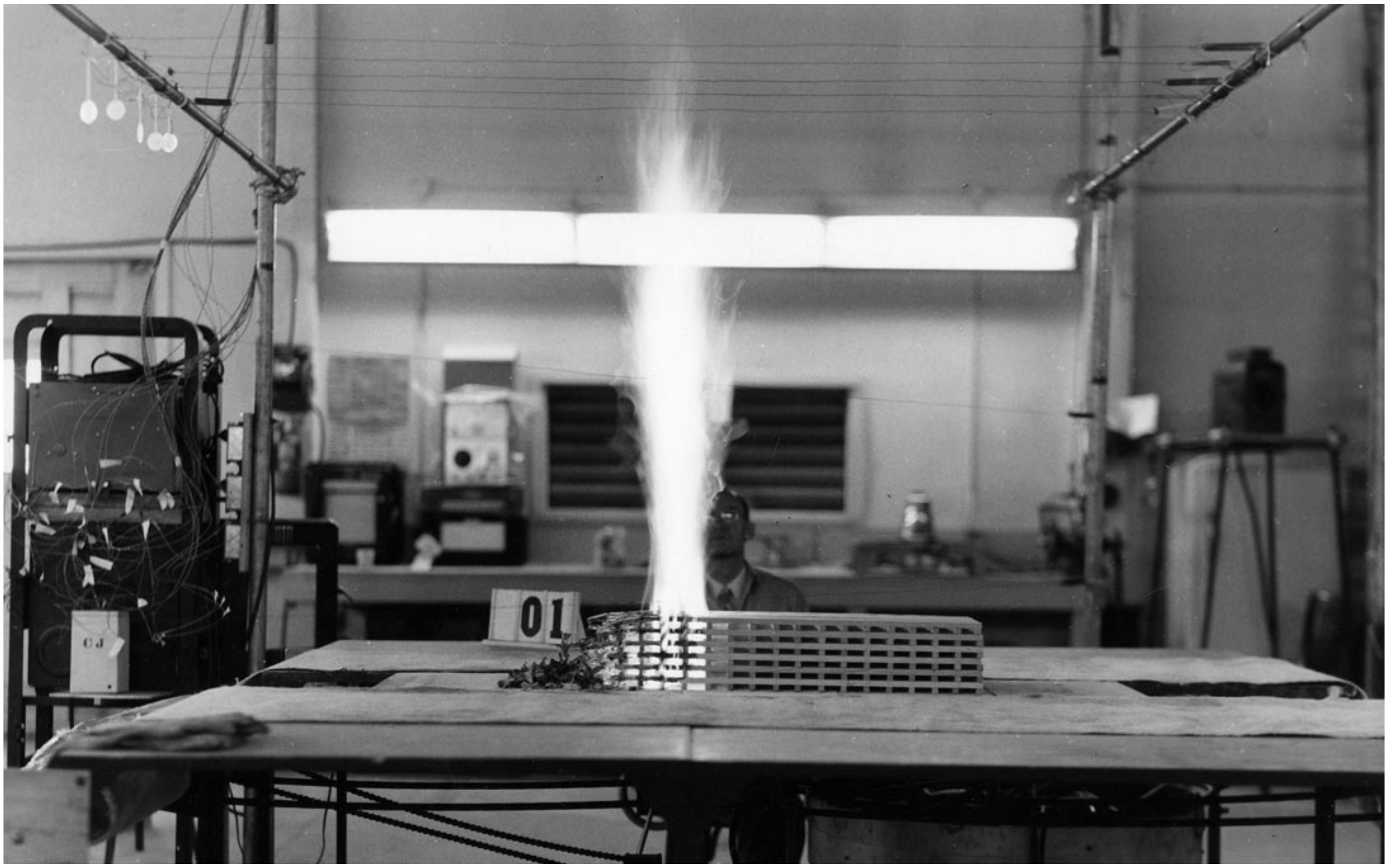
In many cases, Fons's topics required innovative thinking and novel ways of collecting data. His approaches were unusual enough that a national weekly news magazine covered the wind tunnel, a fire table, and a spinning fire wheel—all designed to study fire in a controlled, systematic fashion—in an article about forest fire research.[9] Fons measured the flexion of a tree to known wind velocity by putting different trees in a truck bed with the instruments and driving down a road at fixed speeds. This work was extended to measuring the blast effects on individual, isolated trees "planted" in concrete at the Nevada Proving Grounds in what was called Operation Tumbler-Snapper (www.youtube.com/watch?v=JaefRdulTk0). Next, a forest stand was assembled by harvesting trees from Mount Charleston on the Nevada (now Toiyabe) National Forest and transporting them to the flats at the Nevada Proving Grounds for Operation Upshot-Knothole, where a forest was built to represent a typical woodlot in Western Europe.[10] Other blast effects work was performed on the Pacific Proving Grounds at Bikini and Eniwetok atolls during Operation Castle, and in Australia at the Iron Range Test Site. The forest types included ponderosa pine, Douglas-fir (*Pseudotsuga menziesii*), grand devil's claw (*Pisonia grandis R. Br.*), coconut palm (*Cocos nucifera L.*), beach naupaka (*Scaevola sericea* Vahl var. *sericea*), and North Queensland tropical rain forest. Fons died before the testing took place in Australia in 1964. The final report of Operation Blowdown acknowledged that Fons "contributed materially to the success of this experiment,"[11] but his work had already been recognized by the Department of Agriculture: in May 1961 Vice President Lyndon Johnson had presented Fons with the USDA Superior Service Award for "notable pioneering contributions to forest fire research and to national defense including the establishment of the thermal and blast effects of nuclear explosions on forests and other natural cover."[12]

During the late 1950s, fire damage to buildings and forests in the United States became an issue of national concern and led to the establishment of the Committee on Fire Research by the National Research Council of the National Academy of Sciences. To better understand this issue, the Forest Service built three laboratories specifically to study wildland fire—the Southern Forest Fire Laboratory in Macon, Georgia (1958), the Northern Forest Fire Laboratory in Missoula, Montana (1961), and the Western Forest Fire Laboratory in Riverside, California (1963). Fons used his engineering knowledge and previous experience to design the low-speed wind tunnels at the Southern and Northern Forest Fire labs. While these laboratories were in the planning and construction stages, Fons and his team started an eight-year-long project called Project Fire Model to develop and study a laboratory-scale fire, which would provide a diagnostic model of a steady-state, free-burning fire in solid fuel. When the Forest Service moved Project Fire Model from the Pacific Southwest Experiment Station to the Southern Forest Fire Laboratory in 1960, Fons moved to Macon to continue working on it. This project examined fire spread in wood cribs and provided fundamental knowledge about the flame and fire spread, including heat transfer mechanisms. Fons would not live to see its completion; he died on October 20, 1963, in Macon. George Byram assumed leadership of the project upon his death.

COURTESY OF USDA FOREST SERVICE

To determine the strain of wind on a tree stem caused by nuclear blasts, researchers loaded trees into specially equipped trucks and drove them at a known speed to simulate the effects of wind. Here, a white fir tree is being tested.

Wallace Fons married Della Baker in Berkeley, California, in 1929, and together they had two children, Leona and Theodore. As was typical of Forest Service families during this era, Della, Leona, and Ted often accompanied Wally to the remote locations in California where the various experiments were conducted, occasionally



Researchers used wood cribs to gain fundamental knowledge about flame and fire spread in simple fuels that set a basis for today's work in complex fires and fuels. Pictured is H. D. Bruce.

helping by washing a truck or taking water to the crew. Della, who had studied chemistry at the University of California, served as a sounding board and technical editor for much of Wally's unclassified work, effectively functioning as unsung collaborator. □

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NOTES

1. John R. Curry and C. C. Buck, "Problem Analysis: Forest Fire Behavior Research, California Forest and Range Experiment Station," manuscript dated July 1, 1938, National Forest Service Library, Fort Collins, CO.
2. J. R. Curry and W. L. Fons, "Rate of Spread of Surface Fire in the Ponderosa Pine Type of California," *Journal of Agricultural Research* 57(4): 239–367.
3. W. L. Fons, "An Eiffel Type Wind Tunnel for Forest Research," *Journal of Forestry* 38(11): 881–84; and W. L. Fons, "Analysis of Fire Spread in Light Forest Fuels," *Journal of Agricultural Research* 72(3): 92–121.
4. C. C. Buck, H. D. Bruce, C. A. Abell, W. L. Fons, *A Forest Fire Protection Problem Analysis for California* (Berkeley, CA: USDA Forest Service, California Forest and Range Experiment Station, 1941).
5. J. R. Curry and W. L. Fons, "Forest-Fire Behavior Studies," *Mechanical Engineering* 62: 219–25; and W. L. Fons, "Influence of Forest Cover on Wind Velocity," *Journal of Forestry* 38(6): 481–86.
6. C. C. Buck, W. L. Fons, and C. M. Countryman, "Fire Damage from Increased Run-off and Erosion, Angeles National Forest" (Berkeley, CA: California Forest and Range Experiment Station, 1948).
7. G. M. Byram, W. L. Fons, F. M. Sauer, and R. K. Arnold, "Thermal Properties of Forest Fuels," Interim Technical Report AFSWP-404 (Washington, DC: USDA Forest Service, Division of Fire Research, 1952); and G. M. Byram, F. M. Sauer, W. L. Fons, and R. K. Arnold, "Thermal Conductivity of Some Common Forest Fuels," Interim Technical Report AFSWP-405 (Washington, DC: USDA Forest Service, Division of Fire Research, 1952).
8. T. G. Storey and W. L. Fons, "Natural Period Characteristics of Selected Tree Species," Interim Technical Report AFSWP-864 (Washington, DC: USDA Forest Service, Division of Fire Research, 1956); T. G. Storey, W. L. Fons, and F. M. Sauer, "Crown Characteristics of Several Coniferous Tree Species," Interim Technical Report AFSWP-416 (Washington, DC: USDA Forest Service, Division of Fire Research, 1955); and W. L. Fons and W. Y. Pong, *Tree Breakage Characteristics under Static Loading Ponderosa Pine*, Technical Report AFSWP-867 (Washington, DC: USDA Forest Service, Division of Fire Research, 1957).
9. Alva G. Neuns, "Forest Fire," *Collier's Magazine*, July 22, 1955, 30–33.
10. F. M. Sauer, R. K. Arnold, W. L. Fons, and C. C. Chandler, "Operation UPSHOT-KNOTHOLE, Nevada Proving Grounds, Project 8.11b, Ignition and Persistent Fires Resulting from Atomic Explosions—Exterior Kindling Fuels: Report to the Test Director," WT-775 (Washington, DC: USDA Forest Service, Division of Fire Research, 1953).
11. W. L. Fons and T. G. Storey, "Operation Castle, Project 3.3, Blast Effects on Tree Stand: Report to the Test Director," WT-921 (Washington, DC: USDA Forest Service, Division of Fire Research, 1955); and W. L. Fons, F. M. Sauer, and W. Y. Pong, "Blast Effects on Forest Stands by Nuclear Weapons," Technical Report AFSWP-971 (Washington, DC: USDA Forest Service, Division of Fire Research, 1957).
12. Quote is from the certificate presented by Johnson and is in the possession of Ted Fons.